

**LAWRENCE LIVERMORE NATIONAL LABORATORY 7000 EAST AVENUE, L-198,
LIVERMORE, CALIFORNIA, 94550** Prepared by LLNL under Contract DE-AC52-07NA27344

DATE: July 30, 2018

SUBJECT: Report of Foreign Travel to Trieste, Italy

TO: Dr. Angela Chambers, USDOE Nuclear Criticality Safety Program Manager, National Nuclear Security Administration, NA-511

FROM: Catherine Percher, Nuclear Criticality Safety Division, Lawrence Livermore National Laboratory

MEETING TITLE:

Joint ICTP-IAEA Workshop on the Evaluation of Nuclear Reaction Data for Applications

MEETING LOCATION:

International Centre for Theoretical Physics, Trieste, Italy

MEETING DATES: October 1-14, 2017

ATTENDEES ON BEHALF OF NCSP:

Catherine Percher

MEETING BENEFIT TO NCSP:

This workshop was a joint International Center for Theoretical Physics (ICTP) and International Atomic Energy Agency (IAEA) collaboration focused on the state of the art in how nuclear data is measured, modeled, evaluated, and validated. C. Percher is a researcher and critical experiment designer at LLNL funded by the DOE Nuclear Criticality Safety Program. One of the main goals in designing critical experiments is to design an experiment that will be useful in nuclear data evaluation, and thus understanding the complexities of nuclear data will ultimately aid C. Percher in designing experiments to better accomplish that goal.

MEETING PURPOSE:

The workshop was designed to cover all aspects of nuclear data and was presented in a two-week format. The first week was coordinated by Arjan Koning, the IAEA Nuclear Data Section Leader, and focused on experimental nuclear data measurements and techniques and nuclear structure and reaction models used to generate nuclear data. During the first week, presentations from experimentalists were given in the basic principles and techniques used in measurements of nuclear reaction data, particularly for neutron-induced reaction cross sections and resonance

reactions. Modern nuclear theories for structure and reaction modeling were also covered, together with an introduction to the nuclear reaction code, TALYS.

The second week was coordinated by Jean-Christophe Sublet, also of the IAEA's Nuclear Data Section, and focused on the process of evaluation of experimental nuclear data, including the ENDF format and an overview of the available major nuclear reaction data libraries. As part of this week of the course, Skip Kahler (LANL), provided a half-day tutorial on the use of NJOY to process nuclear data libraries.

In the second week, the workshop participants were asked to give a short presentation of their work, and C. Percher provided an overview of the NCSP's Thermal/Epithermal Experiments (TEX) project. The schedule of the presentations from the workshop is attached.

- Monday, 2 October 2017




- 08:30 - 17:30

Location: Adriatico Guest House - Giambiagi Lecture Hall

- 08:30 **Registration, Administrative and Financial formalities 1h0'**

- All financially supported participants lodging at ICTP Guesthouses should reach the Operations and Travel Unit at the Enrico Fermi Building in order to fulfill all financial procedures.*
 - Please bring with you passport and travel receipts.*
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Registration at Adriatico Guesthouse (Office n. 3): only for participants lodging outside ICTP premises and faculty.



- 09:30 **Introduction to the Workshop 30'**
Speaker: Arjan Koning, Claudio Tuniz
 - 10:00 **Neutron induced reaction cross sections in the resonance region 1h0'**
Speaker: Peter Schillebeeckx
Material:  **Slides**
 - 11:00 **Coffee break 30'**
 - 11:30 **Experimental facilities and techniques 1h30'**
Speaker: Stephan Pomp
Material:  **Slides**
 - 13:00 **Lunch break 1h0'**
 - 14:00 **Neutron time-of-flight measurements 1h30'**
Speaker: Peter Schillebeeckx
Material:  **Slides**
 - 15:30 **Coffee break 30'**
 - 16:00 **Nuclear data measurements I 1h30'**
Speaker: Stephan Pomp
Material:  **Slides**

- Tuesday, 3 October 2017

- 09:00 - 20:00



Location: Adriatico Guest House - Giambiagi Lecture Hall

- 09:00 **Nuclear structure ingredients for reaction models 1h30'**
Speaker: Stephane Goriely
Material:  **Slides**
 - 10:30 **Coffee break 30'**
 - 11:00 **The TALYS nuclear model code I 1h30'**
Speaker: Arjan Koning
Material:  **Slides**

- 12:30 **Lunch break** 1h30'
- 14:00 **Experimental determination of total and partial cross section data** 1h30'
Speaker: Peter Schillebeeckx
Material:  **Slides**
- 15:30 **Coffee break** 30'
- 16:00 **Nuclear data measurements II** 1h30'
Speaker: Stephan Pomp
Material:  **Slides**
- 19:00 **Welcome Reception** 1h0' (Adriatico Guest House - Cafeteria)

All participants are cordially invited.

• Wednesday, 4 October 2017

- 09:00 - 17:40
Location: Adriatico Guest House - Giambiagi Lecture Hall
- 09:00 **Evaluation of uncertainties and adjustment of res. parameters** 1h30'
Speaker: Peter Schillebeeckx
Material:  **Slides**
- 10:30 **Coffee break** 30'
- 11:00 **Optical model and compound nucleus model** 1h30'
Speaker: Stephane Hilaire
Material:  **Slides**
- 12:30 **Lunch break** 1h30'
- 14:00 **Presentations by participants** 1h40'

- 14.00 Marian Boromiza: Inelastic scattering cross sections of protons and neutrons on ^{16}O and ^{28}Si
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- 14.20 Markus Nyman: Inelastic neutron scattering cross-section measurements on ^7Li and $^{63,65}\text{Cu}$
-
- 14.40 Moinul Haque Meaze: Neutron Total cross-sections of Ta, Mo & Pd
-
- 15.00 Adina Olacel: Preliminary results of the neutron inelastic cross section measurements on ^{54}Fe
-

15.20 Bhawna Pandey: Neutron Induced Cross-section of Long-lived Radio-nuclides for Fusion Energy Development

Material:  **Slides**





- 15:40 **Coffee break** 20'
- 16:00 **Presentations by participants** 1h40'

- 16.00 Dmitry Martyanov: *Optical Model with Extended Couplings for Actinides*
-
- 16.20 Mazhar Hussain: *Standardization of nuclear reaction cross section data for the production of medical radionuclides*
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- 16.40 Muhammad Shahid: *Charged Particle Reactions and Production of Medical/Industrial Radioisotopes*
-
- 17.00 Ismail Sarpun: *Effects of Deformation Parameter on Reaction Cross Section*
-

17.20 Haleema Zaneb: *Evaluation of charged particle induced cross section data for production of ^{87}Y*

Material:  **Slides**




- **Thursday, 5 October 2017**

- 09:00 - 17:30
Location: Adriatico Guest House - Giambiagi Lecture Hall
- 09:00 **Level densities and gamma-ray strength functions** 1h30'
Speaker: Stephane Hilaire
Material:  **Slides**
- 10:30 **Coffee break** 30'
- 11:00 **Fission yields** 1h30'
Speaker: Stephan Pomp
Material:  **Slides**
- 12:30 **Lunch break** 1h30'
- 14:00 **Nucleosynthesis model** 1h30'
Speaker: Stephane Goriely
Material:  **Slides**
- 15:30 **Coffee break** 30'
- 16:00 **TALYS exercises** 1h30' (Adriatico Guest House - Denardo Lecture Hall)
Speaker: Arjan Koning, Stephane Goriely, Stephane Hilaire
Material:  **Slides**






- **Friday, 6 October 2017**

- 09:00 - 17:30


Location: Adriatico Guest House - Giambiagi Lecture Hall




- 09:00**Description of fission reactions** 1h30'
Speaker: Stephane Hilaire
- 10:30**Coffee break** 30'
- 11:00**Nuclear models for astrophysics** 1h30'
Speaker: Stephane Goriely
Material:  **Slides**
- 12:30**Lunch break** 1h30'
- 14:00**The TALYS nuclear model code II** 1h30'
Speaker: Arjan Koning
Material:  **Slides**
- 15:30**Coffee break** 30'
- 16:00**TALYS exercises** 1h30' (Adriatico Guest House - Denardo Lecture Hall)
Speaker: Arjan Koning, Stephane Goriely, Stephane Hilaire
Material:  **Slides**

• Monday, 9 October 2017



- 09:00 - 17:30
Location: Adriatico Guest House - Giambiagi Lecture Hall
- 09:00**Introduction to the second week** 10'
Speaker: Jean-Christophe Sublet
- 09:10**Nuclear data libraries** 1h20'
Speaker: Dimitri Rochman
Material:  **Slides**
- 10:30**Coffee break** 30'
- 11:00**Nuclear data for inventory and damage** 1h30'
Speaker: Jean-Christophe Sublet
Material:  **Slides**
- 12:30**Lunch break** 1h30'
- 14:00**Introduction to the FISPACT-II code** 1h30'
Speaker: Jean-Christophe Sublet
Material:  **Slides**
- 15:30**Coffee break** 30'
- 16:00**JANIS** 1h30'
Speaker: Oscar Cabellos
Material:  **Files**  **Slides**

• Tuesday, 10 October 2017

- 09:00 - 17:30
Location: Adriatico Guest House - Giambiagi Lecture Hall
- 09:00**Nuclear data uncertainty quantification and propagation** 1h30'
Speaker: Dimitri Rochman
Material:  **Slides**
- 10:30**Coffee break** 30'

- 11:00**FISPACT-II exercises** 1h30'
Speaker: Michael Fleming
Material:  **Slides**
- 12:30**Lunch break** 1h30'
- 14:00**the NJOY processing code** 1h30'
Speaker: Skip Kahler
Material:  **Slides**
- 15:30**Coffee break** 30'
- 16:00**Creating fission yield libraries with GEF** 1h30'
Speaker: Michael Fleming
Material:  **Slides**

• Wednesday, 11 October 2017

- 09:00 - 17:40
Location: Adriatico Guest House - Giambiagi Lecture Hall
- 09:00**Processing and criticality validation** 1h30'
Speaker: Skip Kahler
Material:  **Slides**
- 10:30**Coffee break** 30'
- 11:00**Benchmarking and validation of integral data** 1h30'
Speaker: Oscar Cabellos
Material:  **Files**  **Slides**
- 12:30**Lunch break** 1h30'
- 14:00**Presentations by participants** 1h40'

- 14.00 Jyoti Pandey: Measurement of $^{59}\text{Ni}(n,p)^{59}\text{Co}$ Reaction Cross-section through Surrogate Technique for Fusion Technology Applications
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- 14.20 Cristiana Oprea: Cross sections of fast neutron reactions with emission of charged particles
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- 14.40 Dmitry Savin: Monte Carlo Simulation of Neutron Spectra in $(n,2n)$ Reactions with Energy-Momentum Conservation
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- 15.00 Lalremruata Hlawndo: A tool for calculation of $^7\text{Li}(p,n)^7\text{Be}$ neutron spectra and the Development of RF power measurement technique for low energy charged particle accelerators
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15.20 Gehan Khalil: Cross Section measurements and nuclear model calculations of neutron and charged particle induced reactions

Material:  **Slides**




- 15:40 **Coffee break** 20'
- 16:00 **Presentations by participants** 1h40'

- 16.00 Clément Jeannesson: IRSN data processing tools in the resonance region
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- 16.20 Mario Matijevic: PCA benchmark analysis using the ADVANTG3.0.1/MCNP6.1.1b codes
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- 16.40 Catherine Percher: The TEX Experiments: New High Precision Integral Experiments for Nuclear Data Validation
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- 17.00 Sanae El Ouahdani: The Analysis of the CREOLE Experiment Using MCNP6.1 Code and ENDF/B-VII.1 library
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17.20 Imam Kambali: Radioactive by-products of a self shielded cyclotron and the liquid target chamber following F-18 radionuclide production

Material:  **Slides**

• Thursday, 12 October 2017

- 09:00 - 17:30
Location: Adriatico Guest House - Giambiagi Lecture Hall
- 09:00 **Nuclear data for power reactors and fuel** 1h30'
Speaker: Dimitri Rochman
- 10:30 **Coffee break** 30'
- 11:00 **Nuclear data at the NEA Data Bank** 1h30'
Speaker: Oscar Cabellos
Material:  **Files**  **Slides**
- 12:30 **Lunch break** 1h30'
- 14:00 **FISPACT-II exercises** 1h30'
Speaker: Michael Fleming
Material:  **Slides**
- 15:30 **Coffee break** 30'
- 16:00 **NJOY exercises** 1h30'
Speaker: Skip Kahler
Material:  **Exercises**

• Friday, 13 October 2017

- 09:00 - 12:30

Location: Adriatico Guest House - Giambiagi Lecture Hall

- 09:00**FISPACT-II applications** *1h30'*

Speaker: Michael Fleming

Material:  **Slides**

- 10:30**Coffee break** *30'*

- 11:00**NJOY exercises** *1h30'*

Speaker: Skip Kahler

Material:  **Exercises**